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Induced quadrupole effects near a crossover in a tetragonal TbLiF 4 sheelite in a strong magnetic field up to 50 T

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Abstract

The anomalies of magnetic properties of TbLiF4 caused by the interaction of the energy levels of a rare-earth ion in a strong magnetic field up to 50 T directed along the [100] and [110] axes are studied experimentally and theoretically. The jumps in magnetization M(H) and the maxima of the differential magnetic susceptibility dM(H)/dH are found in critical fields H c = 28 and 31 T, where the lower component of the excited doublet approaches the ground-state singlet of a Tb3+ ion. Based on the crystal-field model with known interaction parameters, we calculated the Zeeman effect and the magnetization and magnetic susceptibility curves for the TbLiF4 crystal, which adequately describe magnetic anomalies and critical parameters of a crossover. It is shown that the jumpwise change in the α- and γ-symmetry quadrupole interactions in TbLiF4 caused by changes in the corresponding quadrupole moments during the crossing of energy levels leads, in accordance with experiments, to a decrease in the critical field H c by approximately 4 T and an increase in the maximum of the differential susceptibility dM(H)/dH near the crossover more than twofold. This behavior can be considered as an analog of the induced quadrupole transition caused by a change of the ground state of the rare-earth ion during crossover.

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